**CMPG-767 Image processing and Analysis**

**Project 2**

The purpose of this project is to compare the efficiency of spatial domain linear filters

1 (**30 points**). Design the following functions:

a) A function evaluating a root mean square error (RMSE - standard deviation) and peak signal-to-noise ratio (PSNR) between two images.
b) A function for adding Gaussian additive noise to an image. This function shall accept as parameters a clean image and a coefficient determining a noise standard deviation as a fraction of an image standard deviation.
c) (**undergraduate students**)
A function performing mean filtering (Lecture 4, Slide 34) with a 3x3 local neighborhood window and a function performing smart filtering (Lecture 4, Slide 36) with a 3x3 local neighborhood window.

(**graduate students;**
***for undergraduate students 10% extra credit***)
A function performing spatial domain linear filtering of an image with a 3x3 local neighborhood window accepting a filter kernel (3x3 matrix) as a parameter.

Use the **mirrorImage.m** function, which was shared with you, for taking care of boundary effect or design your own function for taking care of it (**the latter gives you 15 extra credit points**).

2 (**15 points**). Design a program, which utilizes the following (use functions, which you designed here in 1 a-b-c) and in Project 1):

a) Measures mean and standard deviation of an image;
b) Adds Gaussian noise to an image;
c) Applies linear filtering with a given kernel to a noisy image;
d) Measures standard deviation and PSNR between the noisy image and the clean image and between the filtered image and the clean image.

3. Choose an image $f(x, y)$

4. Generate Gaussian noise $\eta(x, y)$ with the zero man and standard deviations $0.2\sigma$ and $0.3\sigma$ where σ is the standard deviation of the initial image

5 (**5 points**). Create two noisy images by adding the noisy fields component-vise to an image according to the rule presented in Lecture 4, Slide 21.

6. (**25 points**)

(**undergraduate students**)

Filter your noisy images using a **mean** filter and **smart filter** determined by the following kernel

$$\frac{1}{16}\begin{pmatrix}1 & 2 & 1\\2 & 4 & 2\\1 & 2 & 1\end{pmatrix}$$

and evaluate RMSE and PSNR for your filtered images.

(**graduate students**
***for undergraduate students 10% extra credit***)

Filter your noisy images using a **smart filter** determined by the following kernel

$$\frac{1}{16}\begin{pmatrix}1 & 2 & 1\\2 & 4 & 2\\1 & 2 & 1\end{pmatrix}$$

and evaluate RMSE and PSNR for your filtered images.

Following the idea of smart filtering (Slides 6 and 7 of Lecture 5) try to find another kernel outperforming $\frac{1}{16}\begin{pmatrix}1 & 2 & 1\\2 & 4 & 2\\1 & 2 & 1\end{pmatrix}$ in terms of PSNR.

7. Save all your images and create a table with the summary of your results
(Kernel 1 (which was given), Kernel 2 (which you found), and corresponding RMSE & PSNR)

9 (**25 points**). Repeat steps 3-7 for another image.

10. Write a brief technical report summarizing your results.

11. Turn your source code, resulting images and the report in a single zip file.